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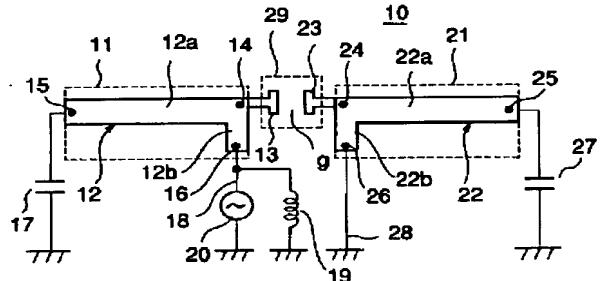
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(54)【発明の名称】複共振アンテナ

(57)【要約】

【課題】複共振アンテナの電気的体積は誘電体の基体の大きさで決まるが、基体を大きくすると加工精度が悪くなり、電気的体積の大きな複共振アンテナを作製するのが困難であった。

【解決手段】給電励振子11及び無給電励振子21を夫々個別に構成する。この給電励振子11及び無給電励振子21は、これらとは別に設けた電界結合手段13, 23で電界結合する。この構成により、複共振アンテナ全体を1枚の誘電体の基体に構成する必要はなくなる。例えば、給電励振子11及び無給電励振子21毎に夫々誘電体の基体で構成し、通常の回路基板に電界結合手段13, 23を形成し、回路基板上で給電励振子11及び無給電励振子21と電界結合手段13, 23を接続すると、十分な大きさの電気的体積を持った複共振アンテナが得られる。



## 【特許請求の範囲】

【請求項1】 一端に給電端子を有する第1の放射電極の中間部に電界結合端子を接続してなる給電励振子と、一端に接地端子を有する第2の放射電極の中間部に電界結合端子を接続してなる無給電励振子と、前記給電励振子及び前記無給電励振子とは別に設けられて、前記給電励振子と前記無給電励振子の電界結合端子を電界により結合する電界結合手段と、前記給電励振子の給電端子に信号電流を流す給電回路と、前記無給電励振子の接地端子を接地する接地回路とから構成することを特徴とする複共振アンテナ。

【請求項2】 前記給電励振子及び前記無給電励振子は、放射電極を形成する誘電体の基体を個別に備え、前記電界結合手段は、回路基板に対向配置した一対の電界結合パターンで構成すると共に、前記給電励振子及び前記無給電励振子を前記回路基板上に載置して、前記給電励振子の電界結合端子を前記一方の電界結合パターンに接続し、前記無給電励振子の電界結合端子を前記他方の電界結合パターンに接続して構成したことを特徴とする請求項1に記載の複共振アンテナ。

【請求項3】 前記一対の電界結合パターンを近接配置して容量成分を付与したことを特徴とする請求項2に記載の複共振アンテナ。

【請求項4】 前記一対の電界結合パターン間にコンデンサを接続したことを特徴とする請求項2に記載の複共振アンテナ。

【請求項5】 前記給電励振子と前記無給電励振子の間には、前記給電回路のインピーダンスを整合すると共に前記給電回路と前記接地回路との間に流れる電流を調整する整合兼用電流結合手段を備えたことを特徴とする請求項1乃至請求項4の何れか1つに記載の複共振アンテナ。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】 本発明は、複数の周波数を使用する移動体通信機器などに用いる複共振アンテナに関するものである。

## 【0002】

【従来の技術】 近年、携帯電話機などの移動体通信機器では、交信チャンネルの混雑を解消するため、1台の携帯電話機で2つの周波数を切替て使用するものがあり、このような2つの周波数を使用するには、携帯電話機に搭載されるアンテナが2つの周波数の電波を送受信する機能を有することが要求される。このようなアンテナの事例には、特開平9-260934号公報に記載されている複共振アンテナが有る。このアンテナは、818MHzのデジタル信号周波数と873MHzのアナログ信号周波数との同調を取ることにより、2つの周波数帯域をカバーするものであり、図13に示すように、異なる周波数で励振される2つの励振子を備えている。

【0003】 図13に於いて、2つの周波数で励振する複共振アンテナ1は、1枚の誘電体で作られた基体2の上に、2つの放射電極3、4を間隔dを設けて平行に配設して構成されている。放射電極3、4は、一端側を板状の開放端3a、4aとともに他端側をミアンダ形状に形成し、ミアンダ形状部3b、4bの末端に接地部5、6を設け、この接地部5、6を接地している。また、放射電極3には、ミアンダ形状部3bの端部に給電部7を設け、この給電部7を信号源8に接続している。

【0004】 この構成により、信号源8から信号の供給を受ける放射電極3が給電励振子となり、信号を入力しない放射電極4が無給電励振子となる。放射電極4は、間隔dを介して放射電極3と電磁結合（主に電界結合）しており、給電励振子と無給電励振子を夫々異なる周波数で励振するものである。

## 【0005】

【発明が解決しようとする課題】 しかしながら、誘電体からなる1枚の基体2上に、2つの放射電極3、4を間隔dを介して併設するので、高周波特性の良い且つ表面積の大きな誘電材料が必要になると共に、アンテナの電気的体積は誘電体で作られた基体2の大きさにより決定される。従って、アンテナの特性を向上させるには基体2自身を大きくする必要があるが、大きな誘電体を精度良く加工するのが難しく、必要なアンテナの電気的体積を確保するのは困難である。

【0006】 特に、誘電材料として優れたセラミックス材料を用いた場合には、焼成時の収縮のため寸法公差が大きくなり、表面積の大きな基体を寸法精度良く作製するのが困難であることに加え、セラミックス材料は回路基板に用いる樹脂材料に比べて高価であるため、基体の価格が上昇し、アンテナを安価に製造することができなく、また、セラミックス材料は回路基板に用いる樹脂材料に比べて非常に重く、アンテナを軽量に構成することができず、ひいては、アンテナを組込んだ使用機器の軽量化に資することができない。

【0007】 本発明は上記課題を解決するために成されたものであり、その目的は、アンテナの電気的体積を確保し且つ複共振特性の良好なアンテナを提供することにある。

## 【0008】

【課題を解決するための手段】 上記目的を達成するため、この発明は次に示す構成をもって前記課題を解決する手段としている。即ち、第1の発明の複共振アンテナは、一端に給電端子を有する第1の放射電極の中間部に電界結合端子を接続してなる給電励振子と、一端に接地端子を有する第2の放射電極の中間部に電界結合端子を接続してなる無給電励振子と、給電励振子及び無給電励振子とは別に設けられて、給電励振子と無給電励振子の電界結合端子を電界により結合する電界結合手段と、給電励振子の給電端子に信号電流を流す給電回路と、無給

電動振子の接地端子を接地する接地回路とから構成することを特徴とするものである。

【0009】上述の構成に於いて、給電動振子は、給電回路を介して信号源から信号電力である共振エネルギーの供給を受けて使用する電波の周波数で共振すると共に、このエネルギーの一部は電界結合手段を介して無給電動振子に供給され、無給電動振子を複共振させる。ここで、複共振とは、給電動振子のリターンロスと無給電動振子のリターンロスが近接しつつも共存し合い、結果として、非常に広範な周波数帯に於いてマッチングの取れた状態をいう。

【0010】また、電界結合手段は、給電動振子及び無給電動振子とは別個に設けられており、両動振子間の結合容量を決定する。この結合容量を適切に設定することにより、給電動振子と無給電動振子の直接的な電界結合なしに、良好な複共振アンテナ特性が得られる。

【0011】第2の発明の複共振アンテナに於いては、上述の発明に於いて、給電動振子及び無給電動振子は、放射電極を形成する誘電体の基体を個別に備え、電界結合手段は、回路基板に対向配置した一対の電界結合パターンで構成すると共に、給電動振子及び無給電動振子を回路基板上に載置して、給電動振子の電界結合端子を一方の電界結合パターンに接続し、無給電動振子の電界結合端子を他方の電界結合パターンに接続して構成したことを特徴とするものである。

【0012】この発明に於いて、給電動振子及び無給電動振子は、夫々誘電体の基体を用いて構成されるので、放射電極を小さく形成でき、動振子自体が小型に構成される。この給電動振子及び無給電動振子は、樹脂材料を主体とした回路基板に載せて固定され、給電動振子と無給電動振子間の結合は、回路基板に形成した一対の電界結合パターンで行われる。

【0013】両電界結合パターンは、所定の間隔を介して配設されており、電界結合パターン間の容量成分により電界結合している。容量成分の大きさは、電界結合パターン間の対向する部分の間隔、対向部分の長さ、対向面積等により決まり、この容量成分の大きさを調整することにより給電動振子と無給電動振子間の電界結合の大きさが調整される。

【0014】第3の発明の複共振アンテナは、第2の発明の構成に於いて、一対の電界結合パターンを近接配設して容量成分を付与したことを特徴とするものである。

【0015】この構成によれば、電界結合パターン間の容量成分を最適な範囲に設定することにより、給電動振子と無給電動振子間の電界結合の強さが最適に定まり、給電動振子及び無給電動振子は調整された複共振の動作をする。

【0016】第4の発明の複共振アンテナは、第2の発明の構成に於いて、一対の電界結合パターン間にコンデンサを接続したことを特徴とするものである。

【0017】この発明では、電界結合パターン間の結合容量はコンデンサの容量値として決まるので、給電動振子と無給電動振子間の最適結合は、コンデンサの値を選択することにより容易に得られる。

【0018】第5の発明の複共振アンテナは、上述の何れかの発明に於いて、給電動振子と無給電動振子の間に、給電回路のインピーダンスを整合すると共に給電回路と接地回路との間に流れる電流量を調整する整合兼用電流結合手段を備えたことを特徴とするものである。

【0019】この発明に於いて、整合兼用電流結合手段は、信号源と給電動振子間のインピーダンスを整合しエネルギーの供給が効率良く行われるように構成すると共に、給電回路と接地回路の間を電流的に結合するものであり、給電動振子と無給電動振子の間に流れる電流量を調整する働きをする。また、給電回路と接地回路を流れる電流の電流量が大きいため、整合兼用電流結合手段は、電流結合に加えて、磁界結合によっても無給電動振子に流れる電流量を調整する構成とすることができる。

【0020】上述の構成に於いて、整合兼用電流結合手段は、インダクタンス成分を有するインダクタンス回路として構成することができる。インダクタンス成分は、インダクタンス値を適宜に設定することにより、給電回路に対するインピーダンスとなるので、確実に複共振アンテナのインピーダンスが整合される。また、インダクタンス回路が一定の長さの回路配線を有する場合には、この回路配線は磁界を発生するので、磁界結合により接地回路に流れる電流量を調整することが可能となる。

【0021】また、整合兼用電流結合手段に接地回路の一部を給電回路に近接させた構成を含めることができ。この構成の採用により、接地回路と給電回路が強く磁界結合し、接地回路に流れる電流量が調整される。

【0022】【発明の実施の形態】以下に、本発明に係る実施形態例を図面に基いて説明する。図1は、本発明に係る複共振アンテナの基本構成を示す。給電動振子11及び無給電動振子21は、夫々、ストリップ状の放射電極12, 22で構成されている。この放射電極12, 22は、導電体を用いて長片12a, 22aと短片12b, 22bから形成されており、放射電極12, 22の全長(長片12a, 22aと短片12b, 22bの和の長さ) Lは、使用する電波に於ける周波数の波長をλ、放射電極12, 22を設けた部分の比誘電率をεとすると、ほぼ、 $L = n \cdot \lambda / 4 \cdot \sqrt{\epsilon}$  となっている。但し、nは自然数である。

【0023】給電動振子11と無給電動振子21の間に、電界結合手段29が形成されている。この電界結合手段29は、例えば、一定の間隔gを介して対向する一対の導電体の電界結合パターン13, 23から構成される。一方の電界結合パターン13は、放射電極12に設けた給電動振子11の電界結合端子14と接続されてお

り、また、他方の電界結合パターン23は、放射電極2に設けた無給電動振子21の電界結合端子24と接続されている。給電動振子11及び無給電動振子21は、一対の電界結合パターン13, 23を介して電界結合する。

【0024】給電動振子11及び無給電動振子21には、放射電極12, 22の長片12a, 22aに於ける開放端部15, 25とグランドの間に、夫々コンデンサ17, 27が接続されている。このコンデンサ17, 27は、通常、放射電極12, 22とグランド間に形成される浮遊容量として与えられる。また、給電動振子11の給電端子16は、放射電極12の短片12bの開放端側に設けられ、給電回路18の信号源20に接続されると共に、インダクタ19を介して接地されている。一方、無給電動振子21の接地端子26は、放射電極22の短片22bの開放端側に設けられ、接地回路28を介して接地されている。

【0025】この構成に於いて、給電動振子11が信号源20から送信信号電力の投入を受けると、放射電極12に高周波の共振電流が流れ、また、無給電動振子21の放射電極22にも電界結合パターン13, 23を介して信号電力が供給され、放射電極22に高周波の共振電流が流れる。給電動振子11から放射される電波の周波数f1は、無給電動振子21から放射される電波の周波数f2と異なり、通常、周波数f1は周波数f2よりも大きくなる。一対の電界結合パターン13, 23は、給電動振子11と無給電動振子21間を電界結合しており、この電界結合パターン13, 23の構成を変えることにより電界結合量を変化させ、アンテナの複共振特性を調整する。

【0026】また、コンデンサ17, 27は、給電動振子11及び無給電動振子21に於いて共振周波数f1, f2を決める共振回路要素となっており、コンデンサ17, 27の容量値を変えることにより共振周波数が変化する。そして、インダクタ19は、信号源20に対しアンテナのインピーダンスを整合させる働きをし、同時に、グランドを介して無給電動振子21の接地端子26と結合して、給電動振子11の給電端子12bと無給電動振子21の接地端子26間を流れる高周波電流量を調整する機能を有している。

【0027】従って、上述の複共振アンテナによれば、給電動振子11及び無給電動振子21の構成を変更することなく、電界結合パターン13, 23を適切に構成することにより最適な複共振特性とすることができる。

【0028】上記複共振アンテナの基本構成の等価回路を図2に示す。図2に於いて、共振インダクタンスL1と放射抵抗R1は放射電極12を現しており、共振インダクタンスL2と放射抵抗R2は放射電極22を現している。また、装荷容量C1は、給電動振子11に接続されたコンデンサ17を現し、装荷容量C2は、無給電動

振子21に接続されたコンデンサ27を現している。

【0029】これら共振インダクタンスL1、放射抵抗R1及び装荷容量C1は、給電動振子11の共振回路を形成しており、同様に、共振インダクタンスL2、放射抵抗R2及び装荷容量C2は、無給電動振子21の共振回路を形成している。2つの共振回路間の結合容量C12は、一対の電界結合パターン13, 23を現し、給電動振子11と無給電動振子21間の電界結合は、等価的には容量結合である。また、結合インダクタンスL12は、インダクタ19を現しており、2つの共振回路間を流れる電流量を調整する。

【0030】この等価回路から明らかのように、2つの共振回路の共振周波数f1, f2を維持しながら良好な複共振を実現するためには、装荷容量C1, C2及び結合容量C12の容量値を整合させる必要がある。結合容量C12は、一対の電界結合パターン13, 23の間隔g、対向面積及び対向部分の長さを適切に設定することにより、装荷容量C1, C2とバランスの取れた結合容量C12とすることが可能である。例えば、樹脂材料を20主体とする回路基板に形成した電界結合パターン13, 23の場合には、間隔g、対向面積及び対向部分の長さの微調整は、トリミング装置で行うことができる。

【0031】また、装荷容量C1, C2は、主に、給電動振子11及び無給電動振子21の構成できまり、給電動振子11及び無給電動振子21に於ける放射電極12, 22とグランド間の浮遊容量を集中定数として現している。

【0032】上述の等価回路に於いて、結合容量C12を大きくすると、換言すれば、電界結合パターン13, 23間の静電容量を大きくすると、給電動振子11と無給電動振子21間の電界結合が強くなり、共振周波数f1と共振周波数f2が分離せず、給電動振子11と無給電動振子21は、恰も1つの励振子の如く動作し、また、そのリターンロスは浅くなる。これとは逆に、結合容量C12が小さくなると、換言すれば、電界結合パターン13, 23間の静電容量を小さくすると、給電動振子11と無給電動振子21間の電界結合が弱くなり、給電動振子11と無給電動振子21は、夫々独立した動作を強め、複共振の周波数特性が得られなくなる。

【0033】また、装荷容量C1, C2を大きくすると、相対的に結合容量C12が小さくなり、換言すれば、電界結合パターン13, 23に於ける電界結合が弱くなり、上述の如く、共振周波数f1, f2による複共振が得られなくなる。逆に、装荷容量C1, C2を小さくすると、相対的に結合容量C12が大きくなり、等価回路の容量バランスが崩れたものとなる。換言すれば、結合容量C12の増大は、電界結合パターン13, 23に於ける電界結合の増大となって、上述の如く、給電動振子11及び無給電動振子21の共振周波数f1, f2が接近して複共振とならなくなる。

【0034】図3は、本発明の複共振アンテナに係る具体的な実施形態例を示す。図3に於いて、複共振アンテナ30は、樹脂材料を主体として作られた回路基板31に2つのアンテナチップ41, 51を載置して構成される。回路基板31は、表面にアンテナ形成部31aとグランド部31bが設けられており、裏面には図示しない回路配線が形成されている。グランド部31bには、絶縁基板の上に銅箔などを貼付して形成したグランド層が設けられている。回路基板31のアンテナ形成部31aには、略T字形の一対の電界結合パターン32, 33がT字形状部分を一定の間隔gを介して対向し、導電体によりパターン形成されている。

【0035】また、アンテナ形成部31aには、給電回路となる給電パターン34及び接地回路となる接地パターン35がパターン形成されている。給電パターン34は、グランド部31bのグランド層から電気絶縁されて形成され、グランド部31bにはチップインダクタ40を介して接続されている。この給電パターン34は、図示しない信号配線に接続されている。また、接地パターン35は、グランド部31bのグランド層に接続されている。

【0036】上述した電界結合パターン32, 33、給電パターン34及び接地パターン35は、グランド部31bのグランド層と同じ導電体であり、エッチング等の周知の方法により一度にパターン形成される。

【0037】アンテナチップ41, 51は、誘電体の基体43, 53の表面に放射電極42, 52を備えている。放射電極42と放射電極52の対向する側の端部

(対向端部)には、帯状の電界結合端子44, 54が設けられている。この電界結合端子44, 54は、夫々基体43, 53の側面を垂下し先端が基体43, 53の裏面側に回り込んで形成されている。そして、一方の電界結合端子44は、電界結合パターン32のT字形状部分と反対側の端部に接続され、他方の電界結合端子54は、電界結合パターン33のT字形状部分と反対側の端部に接続されている。

【0038】また、放射電極42の対向端部には、帯状の給電端子46が設けられ、この給電端子46は、基体43の表面を電界結合端子44に対して直角の方向に伸張し且つ基体43の側面を降下して基体43の裏面側に回り込んで形成されている。この給電端子46は、回路基板31の表面に設けた給電パターン34の一端に接続されている。放射電極52の対向端部には、帯状の接地端子56が設けられており、この接地端子56は、基体53の表面を電界結合端子54に対して直角の方向に伸張して設けられ且つ基体53の側面を降下して基体53の裏面側に回り込んで形成され、接地パターン35に接続されている。

【0039】更に、放射電極42, 52の開放端部47, 57は、電界結合端子44, 54の反対側に於いて

て、夫々基体43, 53の側面の途中まで垂下して形成されている。そして、この開放端部47, 57を設けた同じ側面には、これら開放端部47, 57に対し一定の間隔を介して固定端子48, 58が形成されている。固定端子48, 58は、基体43, 53の裏面まで伸張して設けられており、回路基板31に形成した固定パターン36, 37に接続されている。

【0040】上述の具体的な実施形態例に於いて、給電パターン34は、図示しない送信回路及び受信回路に接続されており、放射電極42, 52から送受信される高周波電流の通路となる。例えば、送信信号電流は、給電端子46から放射電極42に流入し、共振電流を励起すると共に、電界結合端子44から電界結合パターン32, 33を通って電界結合端子54に供給され、放射電極52の共振回路を励振する。このとき、接地端子56にはグランドに向け高周波電流が流れる。

【0041】給電励振子41と無給電励振子51は、電界結合パターン32, 33で電界結合しており、電界結合量を変えることにより、給電励振子41と無給電励振子51との間の結合を調整し、良好な複共振マッチングを得ることができる。電界結合パターン32, 33の等価容量は、電界結合パターン32, 33間の間隔g及び対向部分の長さで決まる。

【0042】また、放射電極42, 52の開放端部47, 57と固定端子48, 58の間には、夫々開放端容量が形成されており、放射電極42, 52に於ける共振回路の回路素子として働き、放射電極42, 52に流れる共振電流の周波数を決める要素となる。

【0043】更に、給電パターン34とグランド部31bとの間に接続されたチップインダクタ40は、給電配線のインピーダンス、例えば、 $50\Omega$ に対しアンテナのインピーダンスを整合させるものであり、これにより、アンテナと信号源20間のインピーダンスの整合が得られ、損失なく信号の送受信ができる。また、チップインダクタ40は、グランド部31bを介して接地パターン35と電気的に結合しており、給電励振子41と無給電励振子51間を流れる高周波電流の通路となっている。ここに、チップインダクタ40は、給電励振子41と無給電励振子51間の電流回路のインピーダンスとなり、給電励振子41と無給電励振子51間の電流結合量を決定している。

【0044】上述したように、電界結合パターン32, 33間の構成を変えることにより、給電励振子41と無給電励振子51間の電界結合量を決定し、アンテナの複共振特性を調整することができる。また、チップインダクタ40のインダクタンス値を選ぶことにより、給電ラインに対するアンテナのインピーダンスを整合すると共に給電励振子41と無給電励振子51間の電流結合量を調整することができる。

【0045】なお、上述の実施形態例では、給電励振子

41と無給電励振子51の放射電極42, 52は、対称の形状に形成したので、例えば、放射電極42, 52をスクリーン印刷などで形成する際に、無給電励振子51の放射電極52には、給電励振子41の放射電極42で利用したマスクの反転パターンを使用できるので、チップアンテナ41, 51の製造コストを引下げることができる。

【0046】また、上述の実施形態例では、回路基板31のアンテナ形成部31aには、電界結合パターン32, 33、給電パターン34、接地パターン35及び固定パターン36, 37のみが設けられ、グランド層は存在しないが、固定パターン36, 37を伸ばしてグランド部31bのグランド層に接続しても良い。これらはアンテナ複共振特性を考慮して決められる。

【0047】更に、上述の実施形態例では、チップアンテナ41, 51は、その長手方向を直線状に配列しているが、その配列は設計のとき自由に定めることができる。例えば、チップアンテナ41, 51は、長手方向が平行となるように配置したり、チップアンテナ41, 51の長手方向が一方を他方に対して直角状に配列したり、また、チップアンテナ41, 51を相互に傾けて、例えば、ハの字に配置しても良い。

【0048】このようなチップアンテナ41, 51の自由な配置は、電界結合パターン32, 33を回路基板31に設け、この電界結合パターン32, 33を利用して2つのチップアンテナ41, 51を電界結合する構成により初めて実現可能となるものであり、これにより、無線機器の筐体に合わせたチップアンテナ41, 51の配置が可能となるので、複共振アンテナ設計の自由度が増大する。

【0049】更にまた、上述の実施形態例では、チップアンテナ41, 51は、複共振状態に於いて、独自の共振周波数f1, f2を持ってるので、チップアンテナ41, 51は、寸法が相互に相違していても良く、また、基体43, 53の比誘電率も相互に相違させることができ、基体43, 53の形状も放射電極42, 52の形成表面が長方形のみならず、正方形であっても良い。

【0050】更にまた、上述の実施形態例では、2つのチップアンテナ41, 51は、放射電極42, 52の形状を対称としたが、これは非対称であっても良く、例えば、一方の放射電極を板状に形成し、他方の放射電極をミアンダ形状に形成しても良い。また、2つのチップアンテナ41, 51の放射電極42, 52をミアンダ形状に形成するときには、つづら折れ状の放射電極を、一方は基体表面の長手方向に伸張し、他方は基体表面の短手方向に伸張する構成と/orすることができ、また、一方をつづら折れ状の放射電極とし、他方を渦巻き状の放射電極とするなど、自由に設計することができる。従って、2つのチップアンテナ41, 51の放射電極42, 52を形成する際にも設計の自由度が大きくなる。

【0051】上記何れの実施形態例の場合でも、回路基板を利用することにより、給電励振子及び無給電励振子は小さく構成しても、複共振アンテナとしての領域を広く取れるので、アンテナの電気的体積が増大し、周波数帯域幅の広い高利得の複共振アンテナを安価に製造することができる。

【0052】図4乃至図6に示す実施形態例は、給電励振子と無給電励振子を電気的に結合する他の構成を示すもので、図3の実施形態例と同一構成部分には同一符号10を付し、その共通部分の重複説明は省略する。

【0053】図4に於いて、給電励振子41を接続する電界結合パターン61は、回路基板31に於けるアンテナ形成部31aの表面に形成され、無給電励振子51を接続する電界結合パターン62は、回路基板31の裏面に形成されている。電界結合パターン61, 62の先端部分は、回路基板31を介して上下に重なっており、電界結合パターン61, 62間には、回路基板31の厚みと対向面積に応じた結合容量が発生し、給電励振子41と無給電励振子51間を容量結合する。

【0054】この結合容量は、電界結合パターン61, 62の対向面積を変えることにより変更することができる。また、無給電励振子51の電界結合端子54は、回路基板31の表面側に設けた中継パターン63に接続され、この中継パターン63は、スルーホール64を通して電界結合パターン62に接続される。

【0055】図5に示す実施形態例は、無給電励振子51を回路基板31の裏面側に配置した点で図4の実施形態例と相違する。無給電励振子51の電界結合端子は、図3と同様に、直接電界結合パターン62に接続されている。回路基板31の裏面には固定パターン66が設けられ、この固定パターン66に無給電励振子51の固定端子58が接続されている。この構成により、回路基板31に於けるアンテナ形成部31aの表裏面の空間が有効に利用される。

【0056】また、図6の実施形態例は、電界結合手段29として、2つの電界結合パターン68, 69を結合容量が形成される間隔を介して配置する代りに、2つの電界結合パターン68, 69がコンデンサ70で結合されている。コンデンサ70には、チップコンデンサが使用される。この構成により、給電励振子41と無給電励振子51間は、コンデンサ70で結合され、コンデンサ70の容量値を変えることにより、給電励振子41と無給電励振子51間の結合度を変えることができる。

【0057】図7乃至図11に示す実施形態例は、信号源に対し複共振アンテナのインピーダンスを整合すると共に給電励振子と無給電励振子との間の電流結合量を調整する他の構成を示すもので、図3の実施形態例と同一構成部分には同一符号を付し、その共通部分の重複説明は省略する。

【0058】図7及び図8に於いて、給電励振子41の

基体43の側面には、図3のチップインダクタ40を用いたインダクタ回路に代えて、一端を給電端子46に接続した電極パターン71が形成されている。この電極パターン71の他端は、回路基板31のアンテナ形成部31aに形成した連結パターン72を介してグランド部31bのグランド層に接続されている。電極パターン71は、ミアンダ形状に形成されてインダクタ成分が付与される。

【0059】この構成に於いて、図3のチップインダクタ40と同様に、電極パターン71のインダクタ値により、信号源に対し複共振アンテナのインピーダンスが整合される。また、連結パターン72は、グランド部31bを介して接地パターン35と電気的に結合しており、給電励振子41と無給電励振子51間は、電極パターン71のインピーダンスを介して電流結合し、給電励振子41と無給電励振子51間を流れる電流量が調整される。この場合、連結パターン72と接地パターン35が近接して設けられたときには、磁界結合によっても接地パターン35を流れる電流量を決めることができる。

【0060】上述の構成によれば、電極パターン71は、給電励振子41に於ける基体43の表面に形成されるから、給電励振子41を作製するとき、放射電極42の形成と同じ製造方法で形成することができ、また、連結パターン72は、給電パターン34及び接地パターン35の形成と同時に回路基板31に形成することができる。

【0061】図9の実施形態例は、インダクタ成分を有するパターンをアンテナチップ41の基体43に設ける代りに回路基板31に設けた点で図7の実施形態例と相違している。なお、発明の構成を明確に示すため、チップアンテナ41, 51を点線で示している。回路基板31のアンテナ形成部31aの表面には、インダクタ回路として給電パターン34に連結したミアンダ形状のインダクタ回路パターン73が形成されている。

【0062】インダクタ回路パターン73のインダクタ値は、複共振アンテナからの送受信信号電力が最大となる値に設定される。また、インダクタ回路パターン73は、接地パターン35の近くでグランド部31bのグランド層に接続されており、インダクタ回路パターン73と接地パターン35は、電流結合と共に磁界結合をする。

【0063】即ち、インダクタ回路パターン73及び接地パターン35を流れる電流量が大きいので、これらのパターン35, 73から発生する磁界強度が大きくなる。この場合にも、インダクタ回路パターン73は、上述同様に、インピーダンスを整合すると共に、2つのチップアンテナ41, 51間の電流結合量を決める他、磁界結合量によっても2つのチップアンテナ41, 51間を流れる電流量を調整する。

【0064】図10実施形態例は、図3に示す実施形態

例に、チップアンテナ41, 51間に磁界結合の手段を付与したものである。なお、チップアンテナ41, 51を点線で示している。チップアンテナ51の接地端子56を接続する接地パターン74には、湾曲部74aが設けられ、給電パターン34に接近してグランド部31bのグランド層に接続されている。

【0065】この構成によれば、給電パターン34に流れる電流量が多いことから、上述したチップインダクタ40による整合機能に加えて、給電パターン34と接地パターン74には磁界結合が生じ、チップアンテナ41, 51間に流れる電流量を調整することができる。また、湾曲部74aの形態を変えることにより、接地パターン74と給電パターン34間の結合度合いを変えることができる。

【0066】また、図11は、2つのチップアンテナ41, 51間にインダクタを設けて直接電流結合した実施形態例である。なお、チップアンテナ41, 51を点線で示している。回路基板31に形成した給電パターン34には、給電引出パターン75を連設し、接地パターン35からは接地引出パターン76を引出して、この給電引出パターン75と接地引出パターン76の間にインダクタ77が接続されている。また、チップアンテナ41, 51間に電界結合する電界結合パターン78, 79は、略L字形に構成して対向している。

【0067】この構成では、インダクタ77により、信号源に対する複共振アンテナのインピーダンス整合と2つのチップアンテナ41, 51間に流れる電流量を、インダクタ77のインダクタ値を選定することにより、直接的に調整することができ、複共振アンテナの設計が容易になる。また、電界結合パターン78, 79による電界結合は、図3に示す実施形態例の略T字形の電界結合パターン32, 33に比べて弱くなるが、電界結合パターン78, 79の形状は、インダクタ77による直接的な電流結合との整合を考慮して決められる。

【0068】上述の構成の採用により、給電パターン34と接地パターン35は、インダクタ77を介して直接的に電流結合する。インダクタ77は、そのインダクタ値により、複共振アンテナと信号源の間のインピーダンスを整合すると共に、給電パターン34と接地パターン35の間に流れる電流量を決定する。

【0069】図12実施形態例は、1つの回路基板上に、図3に示した実施形態例の複共振アンテナを2つ併設した2連式複共振アンテナの構成を示す。チップアンテナ81, 82は、複共振を生じる対のチップアンテナであり、チップアンテナ91, 92も複共振を生じる対となるチップアンテナである。チップアンテナ81, 82は、電界結合パターン83, 84を介して電界結合されており、チップアンテナ91, 92も電界結合パターン93, 94を介して電界結合されている。

【0070】チップアンテナ81, 91は、共通給電パ

ターン85に接続されて、信号源から同時に信号電力が投入される。共通給電パターン85とグランド部31bのグランド層間にはインダクタ86が接続されており、信号源に対して2つの複共振アンテナのインピーダンスを整合している。また、2つのチップアンテナ82, 92は、接地パターン87, 88を介して夫々グランド部31bのグランド層に接続されている。

【0071】この構成に於いて、チップアンテナ81, 82による複共振とチップアンテナ91, 92による複共振の周波数帯は離して設定される。例えば、チップアンテナ81, 82が800～900MHzの周波数帯で複共振する場合には、チップアンテナ91, 92は1700～2100MHz帯で複共振するように設定される。換言すれば、相互に干渉を生じない程度に離れた周波数帯に於ける複数の複共振アンテナを共通の回路基板を用いて設計することができる。

【0072】

【発明の効果】請求項1の複共振アンテナによれば、給電励振子及び無給電励振子とは別に両励振子間を結合する電界結合手段を設けたので、両励振子間の電界結合を最適化することにより、反射損失に於ける周波数特性の優れた複共振アンテナを得ることができる。そして、電界結合手段の構成を適宜に設定することにより、アンテナ全体の寸法の拡大に柔軟に対応することができ、給電励振子及び無給電励振子の構成を変えることなくアンテナの電気的体積を増大することができる。

【0073】また、電界結合手段は、給電励振子及び無給電励振子から独立して形成されるため、アンテナの設計の自由度が増し、大電力送受信の用途に十分耐え得るアンテナを提供することができる。更に、給電励振子、無給電励振子及び電界結合手段を含んだ空間をアンテナ全体の電気的体積として利用できるので、広帯域且つ高利得のアンテナを実現することができる。

【0074】請求項2の複共振アンテナによれば、給電励振子及び無給電励振子から独立して一対の電界結合パターンを設けたので、電界結合パターン間の容量を調整することにより給電励振子と無給電励振子間の電界結合量を調整することができる。

【0075】従来に於いては、給電励振子と無給電励振子の構成を変更することにより両励振子間の電磁結合を調整しているが、この発明では、回路基板に形成された一対の電界結合パターン間の容量結合により給電励振子と無給電励振子間の電界結合量を調整するので、給電励振子及び無給電励振子の配置形態を自由に選択できることと共に、励振子を構成する基体の形状、寸法及び誘電率も相互に同じでも異なっていても良く、放射電極の形状及び配置方向も何ら制限を受けない。

【0076】従って、複共振アンテナの周波数及び周波数差の調整は、電界結合パターンで行うことが可能であるから、複共振アンテナ設計の自由度が増し、複共振ア

ンテナの設計が容易になる。特に、電界結合の度合いを回路基板上に形成した電界結合パターンで行うので、大電力で電波を送受信する用途の複共振アンテナを作製することができる。

【0077】また、給電励振子と無給電励振子の部分にのみ誘電体の基体が使用され、給電励振子と無給電励振子を電界結合する電界結合パターンは回路基板上に構成したから、従来のように、複共振アンテナ全体が誘電体の基体で構成されるアンテナとは異なり、複共振アンテナの寸法を柔軟に変更した設計をすることができる。

【0078】特に、複共振アンテナの誘電体をセラミック材料で構成した場合には、給電励振子と無給電励振子の部分にのみセラミック材料の基体が使用され、複共振アンテナ全体に誘電体として大きな寸法のセラミック材料の基体を用いる必要がないので、給電励振子と無給電励振子を加工精度良く作製し、また、複共振アンテナを安価に且つ軽量に作ることができる。

【0079】更に、給電励振子及び無給電励振子の個々の配置に自由度があるので、複共振アンテナが組込まれる移動体通信機器の筐体に合せて柔軟に給電励振子及び無給電励振子の配置を決定することができる。このような場合でも、給電励振子、無給電励振子及び電界結合パターンを含んだ領域全体を複共振アンテナの電気的体積として利用するので、周波数帯域幅の広い高利得の複共振アンテナを実現することができる。

【0080】請求項3の複共振アンテナによれば、電界結合パターンは、給電励振子及び無給電励振子から独立して回路基板に設けられるため、給電励振子及び無給電励振子の構成を考慮することなく種々のパターン構成とすることができ、複共振に於ける給電励振子と無給電励振子の共振周波数の設定及び給電励振子と無給電励振子間の周波数差の調整が容易となる。

【0081】請求項4の複共振アンテナによれば、電界結合パターン間をコンデンサで結合するので、コンデンサの値を選択することにより最適な複共振アンテナとすことができる。

【0082】請求項5の複共振アンテナによれば、整合兼用電流結合手段を給電励振子と無給電励振子の間に設けたので、信号源とのインピーダンス整合が容易であり、また、給電励振子と無給電励振子間を電流結合及び磁界結合させることができ、給電励振子及び無給電励振子の配置関係を考慮することなく、アンテナの電気的体積を増加する場合にも柔軟な設計が可能になる。

【0083】また、整合兼用電流結合手段は、給電励振子及び無給電励振子とは別個に設計することができるのと、給電励振子及び無給電励振子の形状を変形することなく複共振アンテナの寸法を自由に設定し、大電力送信の用途に適した複共振アンテナを得ることができる。

【0084】更に、整合兼用電流結合手段をインダクタス回路で構成したときには、このインダクタス回路

のインピーダンスにより、給電回路に対する複共振アンテナのインピーダンスを整合させることができると共に、インダクタンス回路と接地回路間に流れる電流量が大きくても確実に電流量を調整することができる。また、インダクタンス回路の回路配線を接地回路に近接して配設することにより、磁界結合によっても接地回路に流れる電流量を調整することができる。

【0085】更にまた、整合兼用電流結合手段が、接地回路の一部を給電回路に近接させた構成を含むときには、磁界結合により接地回路に流れる電流量を調節することができると共に、整合兼用電流結合手段を調整することにより、接地回路と給電回路間の結合度合いを変えることができる。

【図面の簡単な説明】

【図1】本発明に係る複共振アンテナの基本構成を示す構成図である。

【図2】図1に示す複共振アンテナの等価回路図である。

【図3】本発明に係る複共振アンテナの具体的構成を示し、(A)は平面図、(B)は(A)の一点鎖線X-Xに於ける一部断面側面図である。

【図4】本発明に係る複共振アンテナの他の構成を示す一部断面側面図である。

【図5】本発明に係る複共振アンテナの更に他の構成を示す一部断面側面図である。

【図6】本発明に係る複共振アンテナの他の構成を示す部分平面図である。

【図7】本発明に係る複共振アンテナの他の構成を示す部分平面図である。

【図8】本発明に係る複共振アンテナに用いるチップアンテナの斜視図である。

【図9】本発明に係る複共振アンテナの更に他の構成を示す部分平面図である。

【図10】本発明に係る複共振アンテナの更に他の構成を示す部分平面図である。

【図11】本発明に係る複共振アンテナの更に他の構成を示す部分平面図である。

【図12】本発明に係る2連式複共振アンテナの構成を示す平面図である。

【図13】従来の複共振アンテナを示す斜視図である。

【符号の説明】

10, 30 複共振アンテナ

11 紙電動子

12, 22, 42, 52 放射電極

13, 23, 32, 33, 61, 62, 68, 69 電界結合パターン

14, 24, 44, 54 電界結合端子

15, 25, 47, 57 開放端部

10 16, 46 紙電端子

17, 27 開放端容量

18 紙電回路

19, 77 インダクタ

20 信号源

21 無紙電動子

26, 56 接地端子

28 接地回路

31 回路基板

31a アンテナ形成部

31b グランド部

34 紙電パターン

35, 74 接地パターン

36, 37, 66 固定パターン

40 チップインダクタ

41, 51 チップアンテナ

43, 53 基体

42a 平面部

42b ミアンダ形状部

48, 58 固定端子

30 63 中継パターン

64 スルーホール

70 コンデンサ

71 電極パターン

72 連結パターン

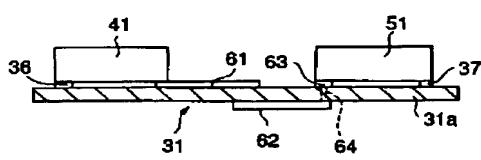
73 インダクタンスパターン

74a 湾曲部

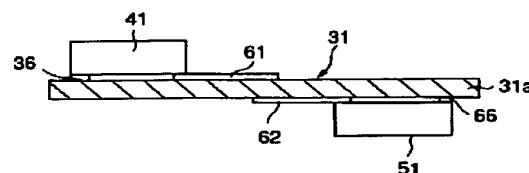
75 紙電引出パターン

76 接地引出パターン

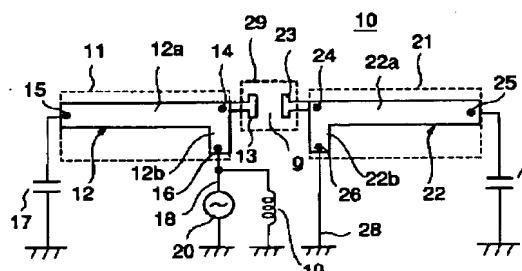
【図4】



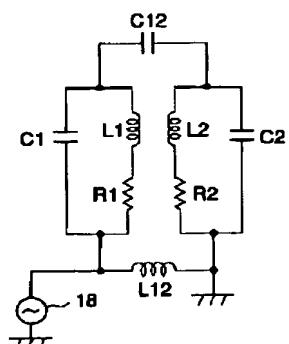
【図5】



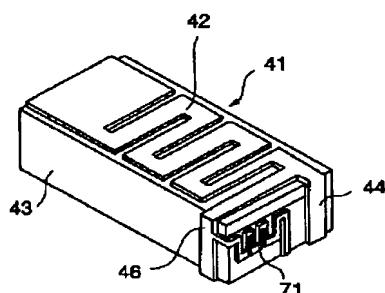
[图 1]



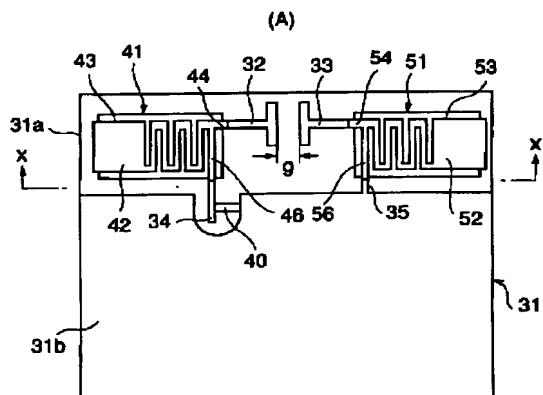
## 【図2】



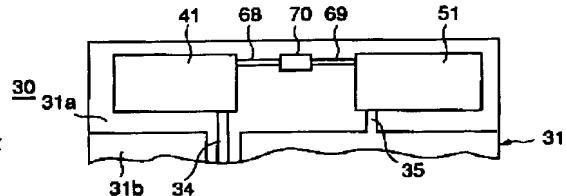
【图8】



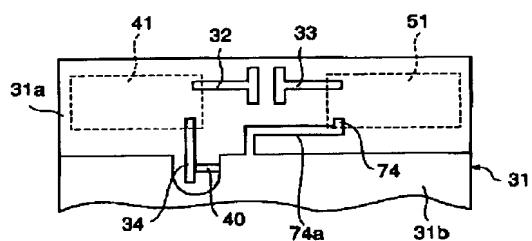
【图3】



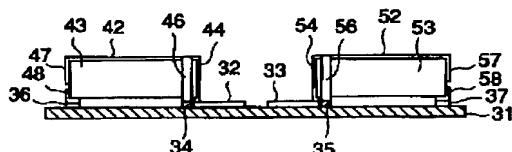
【図6】



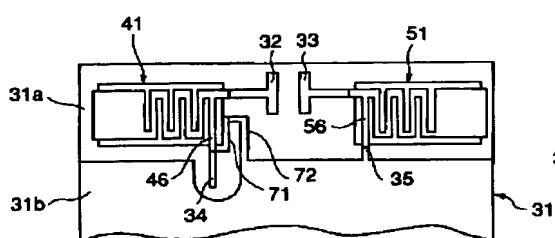
【四 10】



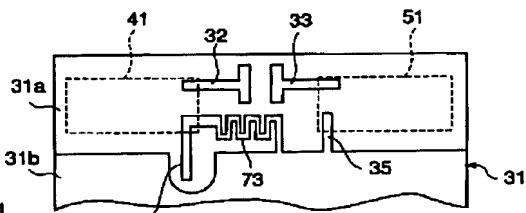
(B)



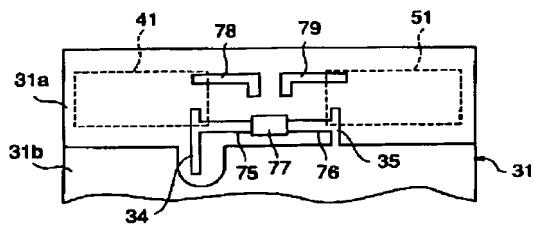
【图7】



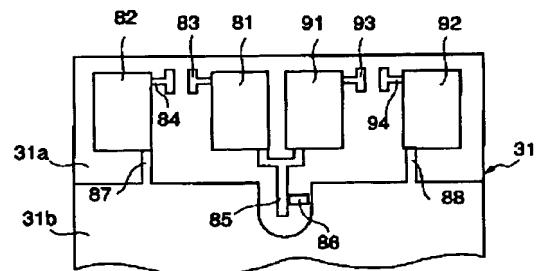
【図9】



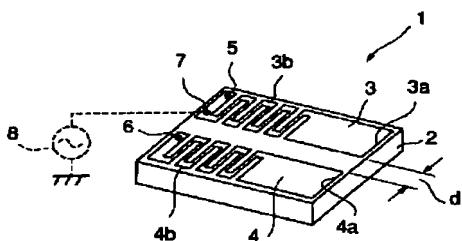
【図11】



【図12】



【図13】



## フロントページの続き

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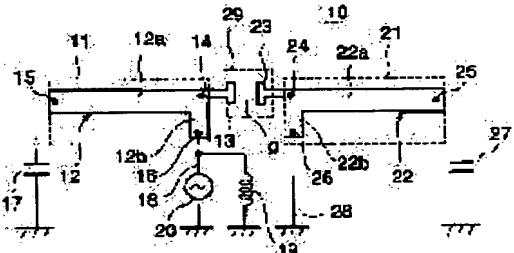
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## (54) PLURAL RESONANCE ANTENNA

## (57)Abstract:

PROBLEM TO BE SOLVED: To provide a plural resonance antenna with an excellent plural resonance characteristic that can ensure the electric volume of the antenna.

SOLUTION: A feeding exciting element 11 and a non-feeding exciting element 21 of the antenna are respectively and individually configured. The feeding exciting element 11 and the non-feeding exiting element 21 are electric-field-coupled by electric field coupling means 13, 23 provided separately. Through the configuration above, it is not required to configure the entire plural resonance antenna on one dielectric base. For example, each of the feeding exciting element 11 and the non-feeding exciting element 21 is respectively configured with the dielectric base, the electric field coupling means 13, 23 are formed on a conventional printed circuit board, the feeding exciting element 11 and the non-feeding exciting element 21 are interconnect to the electric field coupling means 13, 23 on the printed circuit board to realize the plural resonance antenna with an electric volume with a sufficient size.



## LEGAL STATUS

[Date of request for examination]

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[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

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## CLAIMS

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## [Claim(s)]

[Claim 1] With the electric supply excitation child who comes to connect an electric-field joint terminal with the pars intermedia of the 1st radiation electrode which has an electric supply terminal at the end With the non-supplied electric power excitation child who comes to connect an electric-field joint terminal with the pars intermedia of the 2nd radiation electrode which has an earth terminal at the end The electric-field coupling means which are prepared apart from the aforementioned electric supply excitation child and the aforementioned non-supplied electric power excitation child, and combine the electric-field joint terminal of the aforementioned electric supply excitation child and the aforementioned non-supplied electric power excitation child by electric field, The double resonant antenna characterized by constituting from a feeder circuit which passes the signal current for the aforementioned electric supply excitation child's electric supply terminal, and a grounded circuit which grounds the aforementioned non-supplied electric power excitation child's earth terminal.

[Claim 2] The aforementioned electric supply excitation child and the aforementioned non-supplied electric power excitation child have individually the base of the dielectric which forms a radiation electrode. the aforementioned electric-field coupling means While constituting from an electric-field joint pattern of the couple which carried out opposite arrangement in the circuit board The aforementioned electric supply excitation child and the aforementioned non-supplied electric power excitation child are laid on the aforementioned circuit board. The double resonant antenna according to claim 1 characterized by having connected the aforementioned electric supply excitation child's electric-field joint terminal to aforementioned one electric-field joint pattern, having connected the aforementioned non-supplied electric power excitation child's electric-field joint terminal to the electric-field joint pattern of aforementioned another side, and constituting.

[Claim 3] The double resonant antenna according to claim 2 characterized by having carried out proximity arrangement of the electric-field joint pattern of the aforementioned couple, and giving a capacity component.

[Claim 4] The double resonant antenna according to claim 2 characterized by connecting a capacitor between the electric-field joint patterns of the aforementioned couple.

[Claim 5] The double resonant antenna of any one publication of the claim 1 characterized by having the adjustment combination current coupling means which adjust the amount of current which flows between the aforementioned feeder circuit and the aforementioned grounded circuit while adjusting the impedance of the aforementioned feeder circuit between the aforementioned electric supply excitation child and the aforementioned non-supplied electric power excitation child, or the claim 4.

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[Translation done.]

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the double resonant antenna used for the mobile communication equipment which uses two or more frequency.

[0002]

[Description of the Prior Art] In order for there to be some which carry out change \*\*\*\*\* of the two frequency at one set of a portable telephone in order to cancel confusion of a communication channel with mobile communication equipment, such as a portable telephone, in recent years and to use such two frequency, it is required that it should have the function that the antenna carried in a portable telephone transmits and receives the electric wave of two frequency. There is a double resonant antenna indicated by JP,9-260934,A in the example of such an antenna. By taking alignment with the digital signal frequency of 818MHz, and the analog signal frequency of 873MHz, this antenna covers two frequency bands, and as shown in drawing 13, it is equipped with two excitation children excited on different frequency.

[0003] In drawing 13, on the base 2 made from the dielectric of one sheet, the double resonant antenna 1 excited on two frequency forms an interval d, arranges two radiation electrodes 3 and 4 in parallel, and is constituted. The radiation electrodes 3 and 4 formed the other end side in the MIANDA configuration while using the end side as the open ends 3a and 4a of a tabular, they formed the grounding sections 5 and 6 in the end of the MIANDA configuration sections 3b and 4b, and have grounded these grounding sections 5 and 6. Moreover, the electric supply section 7 was formed in the edge of MIANDA configuration section 3b, and this electric supply section 7 is connected to the radiation electrode 3 in the source 8 of a signal.

[0004] By this composition, the radiation electrode 3 which receives supply of a signal from the source 8 of a signal serves as an electric supply excitation child, and the radiation electrode 4 which does not input a signal serves as a non-supplied electric power excitation child. The electromagnetic coupling (mainly electric-field combination) of the radiation electrode 4 is carried out to the radiation electrode 3 through the interval d, and it excites an electric supply excitation child and a non-supplied electric power excitation child on frequency different, respectively.

[0005]

[Problem(s) to be Solved by the Invention] However, since two radiation electrodes 3 and 4 are put side by side through an interval d on the base 2 of one sheet which consists of a dielectric, while a dielectric material with a big surface area with a sufficient RF property is needed, the electric volume of an antenna is determined by the size of the base 2 made from the dielectric. Therefore, although it is necessary to enlarge base 2 self for raising the property of an antenna, it is difficult for processing a big dielectric with a sufficient precision to secure the electric volume of a difficult and required antenna.

[0006] When the ceramic material which was excellent as a dielectric material especially is used A dimensional tolerance becomes large for the contraction at the time of baking, and, in addition to it being difficult to produce a base with a big surface area with a sufficient dimensional accuracy, ceramic material is compared with the resin material used for the circuit board. Since it is expensive, It cannot \*\* to lightweight-ization of the use device which the price of a base rose and could not manufacture an antenna cheaply, and was very heavy compared with the resin material used for the circuit board as for ceramic material, and could not constitute an antenna lightweight, as a result incorporated the antenna.

[0007] this invention is accomplished in order to solve the above-mentioned technical problem, and the purpose is in securing the electric volume of an antenna and offering the good antenna of the double resonance characteristic.

[0008]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention is taken as a means to

solve the aforementioned technical problem with the composition shown below. With namely, the electric supply excitation child by whom the double resonant antenna of the 1st invention comes to connect an electric-field joint terminal with the pars intermedia of the 1st radiation electrode which has an electric supply terminal at the end. With the non-supplied electric power excitation child who comes to connect an electric-field joint terminal with the pars intermedia of the 2nd radiation electrode which has an earth terminal at the end. The electric-field coupling means which are prepared apart from an electric supply excitation child and a non-supplied electric power excitation child, and combine the electric-field joint terminal of an electric supply excitation child and a non-supplied electric power excitation child by electric field. It is characterized by constituting from a feeder circuit which passes the signal current for an electric supply excitation child's electric supply terminal, and a grounded circuit which grounds a non-supplied electric power excitation child's earth terminal.

[0009] In above-mentioned composition, while an electric supply excitation child resonates on the frequency of the electric wave used in response to the resonance energy supply which is signal power through a feeder circuit from the source of a signal, a part of this energy is supplied to a non-supplied electric power excitation child through electric-field coupling means, and it double-resonates a non-supplied electric power excitation child. Here, double resonance lives each other together, although an electric supply excitation child's return loss and a non-supplied electric power excitation child's return loss approach, and the state where matching was able to be taken in the very extensive frequency band as a result is said.

[0010] Moreover, electric-field coupling means are prepared separately from an electric supply excitation child and a non-supplied electric power excitation child, and determine the joint capacity between both excitation children. A good double resonant-antenna property is acquired without a direct electric-field combination of an electric supply excitation child and a non-supplied electric power excitation child by setting up this joint capacity appropriately.

[0011] In the double resonant antenna of the 2nd invention, it sets to above-mentioned invention. an electric supply excitation child and a non-supplied electric power excitation child. It has individually the base of the dielectric which forms a radiation electrode. electric-field coupling means While constituting from an electric-field joint pattern of the couple which carried out opposite arrangement in the circuit board. It is characterized by having laid the electric supply excitation child and the non-supplied electric power excitation child on the circuit board, having connected an electric supply excitation child's electric-field joint terminal to one electric-field joint pattern, having connected a non-supplied electric power excitation child's electric-field joint terminal to the electric-field joint pattern of another side, and constituting.

[0012] In this invention, since an electric supply excitation child and a non-supplied electric power excitation child are constituted using the base of a dielectric, respectively, a radiation electrode can be formed small and the excitation child itself is constituted small. This electric supply excitation child and a non-supplied electric power excitation child put resin material on the circuit board made into the subject, and are fixed, and combination between an electric supply excitation child and a non-supplied electric power excitation child is performed by the electric-field joint pattern of the couple formed in the circuit board.

[0013] The both electric-fields joint pattern is arranged through the predetermined interval, and is carrying out electric-field combination by the capacity component between electric-field joint patterns. The size of a capacity component is decided by the interval of the portion countered between electric-field joint patterns, the length of an opposite portion, the opposed face product, etc., and the size of the electric-field combination between an electric supply excitation child and a non-supplied electric power excitation child is adjusted by adjusting the size of this capacity component.

[0014] The double resonant antenna of the 3rd invention is characterized by having carried out proximity arrangement of the electric-field joint pattern of a couple, and giving a capacity component in the 2nd composition of invention.

[0015] According to this composition, by setting the capacity component between electric-field joint patterns as the optimal range, the strength of the electric-field combination between an electric supply excitation child and a non-supplied electric power excitation child becomes settled the optimal, and an electric supply excitation child and a non-supplied electric power excitation child do operation of the adjusted double resonance.

[0016] The double resonant antenna of the 4th invention is characterized by connecting a capacitor between the electric-field joint patterns of a couple in the 2nd composition of invention.

[0017] In this invention, since the joint capacity between electric-field joint patterns is decided as capacity value of a capacitor, optimum coupling between an electric supply excitation child and a non-supplied electric power excitation child is easily obtained by choosing the value of a capacitor.

[0018] In above-mentioned invention [ which ], between an electric supply excitation child and a non-supplied electric power excitation child, the double resonant antenna of the 5th invention is characterized by having the adjustment combination current coupling means which adjust the amount of current which flows between a feeder circuit and a grounded circuit while it adjusts the impedance of a feeder circuit.

[0019] In this invention, while constituting adjustment combination current coupling means so that the impedance between the source of a signal and an electric supply excitation child may be adjusted and an energy supply may be performed efficiently, they combine between a feeder circuit and grounded circuits in current, and carry out the work which adjusts the amount of current which flows between an electric supply excitation child and a non-supplied electric power excitation child. Moreover, since the amount of current of the current which flows a feeder circuit and a grounded circuit is large, in addition to current combination, adjustment combination current coupling means can be considered as the composition which adjusts the amount of current which flows to a non-supplied electric power excitation child also by magnetic field combination.

[0020] In above-mentioned composition, adjustment combination current coupling means can be constituted as an inductance circuit which has an inductance component. Since an inductance component serves as an impedance to a feeder circuit by setting up an inductance value suitably, the impedance of a double resonant antenna is certainly adjusted. Moreover, when an inductance circuit has circuit wiring of fixed length, since this circuit wiring generates a magnetic field, it becomes possible [ adjusting the amount of current which flows to a grounded circuit by magnetic field combination ].

[0021] Moreover, the composition in which a part of grounded circuit was made to approach a feeder circuit can be included in adjustment combination current coupling means. The amount of current to which a grounded circuit and a feeder circuit carry out magnetic field combination strongly, and flow to a grounded circuit by adoption of this composition is adjusted.

[0022]

[Embodiments of the Invention] Below, the example of an operation form concerning this invention is explained based on a drawing. Drawing 1 shows the basic composition of the double resonant antenna concerning this invention. The electric supply excitation child 11 and the non-supplied electric power excitation child 21 consist of radiation electrodes 12 and 22 of a strip, respectively. These radiation electrodes 12 and 22 are formed using the conductor from the long pieces 12a and 22a and the short pieces 12b and 22b. The overall length (the length of the sum of the long pieces 12a and 22a and the short pieces 12b and 22b) L of the radiation electrodes 12 and 22 is  $L=n\lambda/4$ , and  $\lambda$  is mostly, when specific inductive capacity of the portion which formed  $\lambda$  and the radiation electrodes 12 and 22 for the wavelength of the frequency in the electric wave to be used is set to  $\epsilon$ . It has become. However,  $n$  is the natural number.

[0023] The electric-field coupling means 29 are formed between the electric supply excitation child 11 and the non-supplied electric power excitation child 21. These electric-field coupling means 29 consist of electric-field joint patterns 13 and 23 of the conductor of the couple which counters through the fixed interval  $g$ . One electric-field joint pattern 13 is connected with the electric-field joint terminal 14 of the electric supply excitation child 11 who prepared in the radiation electrode 12, and the electric-field joint pattern 23 of another side is connected with the electric-field joint terminal 24 of the non-supplied electric power excitation child 21 who prepared in the radiation electrode 22. The electric supply excitation child 11 and the non-supplied electric power excitation child 21 do electric-field combination through the electric-field joint patterns 13 and 23 of a couple.

[0024] Capacitors 17 and 27 are connected to the electric supply excitation child 11 and the non-supplied electric power excitation child 21, respectively between the open end sections 15 and 25 in the long pieces 12a and 22a of the radiation electrodes 12 and 22, and the gland. These capacitors 17 and 27 are usually given as stray capacity formed between the radiation electrodes 12 and 22 and a gland. Moreover, the electric supply excitation child's 11 electric supply terminal 16 is grounded through the inductor 19 while being prepared in the open end side of short piece 12b of the radiation electrode 12 and connecting with the source 20 of a signal of a feeder circuit 18. On the other hand, the non-supplied electric power excitation child's 21 earth terminal 26 is formed in the open end side of short piece 22b of the radiation electrode 22, and is grounded through the grounded circuit 28.

[0025] In this composition, if the electric supply excitation child 11 receives the injection of sending-signal power from the source 20 of a signal, the resonance current of a RF flows to the radiation electrode 12, and signal power will be supplied also to the non-supplied electric power excitation child's 21 radiation electrode 22 through the electric-field joint patterns 13 and 23, and the resonance current of a RF will flow to the radiation electrode 22. Unlike the frequency  $f_2$  of the electric wave emitted by the non-supplied electric power excitation child 21, the frequency  $f_1$  of the electric wave emitted by the electric supply excitation child 11 usually becomes larger [ frequency  $f_1$  ] than frequency  $f_2$ . The electric-field joint patterns 13 and 23 of a couple are carrying out electric-field combination of between the electric supply excitation child 11 and the non-supplied electric power excitation child 21, by changing the composition of these electric-field joint patterns 13 and 23, change the amount of electric-field combination, and adjust the double resonance characteristic of an antenna.

[0026] Moreover, capacitors 17 and 27 serve as a resonance circuit element which determines resonance frequency  $f_1$

and f2 in the electric supply excitation child 11 and the non-supplied electric power excitation child 21, and resonance frequency changes by changing the capacity value of capacitors 17 and 27. And an inductor 19 carries out the work which adjusts the impedance of an antenna to the source 20 of a signal, simultaneously, combines with the non-supplied electric power excitation child's 21 earth terminal 26 through a gland, and has the function to adjust the amount of RF current which flows between the earth terminals 26 of the electric supply excitation child's 11 electric supply terminal 12b, and the non-supplied electric power excitation child 21.

[0027] Therefore, according to the above-mentioned double resonant antenna, it can consider as the optimal double resonance characteristic by constituting the electric-field joint patterns 13 and 23 appropriately, without changing the composition of the electric supply excitation child 11 and the non-supplied electric power excitation child 21.

[0028] The equal circuit of the basic composition of the above-mentioned double resonant antenna is shown in drawing 2. In drawing 2, the resonance inductance L1 and radiation resistance R1 express the radiation electrode 12, and the resonance inductance L2 and radiation resistance R2 express the radiation electrode 22. Moreover, the loading capacity C1 expresses the capacitor 17 connected to the electric supply excitation child 11, and the loading capacity C2 expresses the capacitor 27 connected to the non-supplied electric power excitation child 21.

[0029] These resonance inductance L1, radiation resistance R1, and the loading capacity C1 form the electric supply excitation child's 11 resonance circuit, and the resonance inductance L2, radiation resistance R2, and the loading capacity C2 form the non-supplied electric power excitation child's 21 resonance circuit similarly. The joint capacity C12 between two resonance circuits expresses the electric-field joint patterns 13 and 23 of a couple, and the electric-field combination between the electric supply excitation child 11 and the non-supplied electric power excitation child 21 is capacity coupling in equivalent. Moreover, the joint inductance L12 expresses the inductor 19, and adjusts the amount of current which flows between two resonance circuits.

[0030] In order to realize good double resonance, maintaining the resonance frequency f1 and f2 of two resonance circuits so that clearly from this equal circuit, it is necessary to adjust the capacity value of the loading capacity C1 and C2 and the joint capacity C12. Joint capacity C12 can be considered as the loading capacity C1 and C2 and the well-balanced joint capacity C12 by setting up appropriately the length of the interval g of the electric-field joint patterns 13 and 23 of a couple, an opposed face product, and an opposite portion. For example, in the case of the electric-field joint patterns 13 and 23 which formed resin material in the circuit board made into a subject, trimming equipment can perform fine tuning of the length of an interval g, an opposed face product, and an opposite portion.

[0031] Moreover, mainly, the electric supply excitation child 11 and the non-supplied electric power excitation child 21 can constitute the loading capacity C1 and C2, and they expresses the stray capacity between the radiation electrodes 12 and 22 in a ball, the electric supply excitation child 11, and the non-supplied electric power excitation child 21, and a gland as a concentrated constant.

[0032] In an above-mentioned equal circuit, if joint capacity C12 is enlarged, it will put in another way and electrostatic capacity between the electric-field joint pattern 13 and 23 will be enlarged, the electric-field combination between the electric supply excitation child 11 and the non-supplied electric power excitation child 21 will become strong, and resonance frequency f1 and resonance frequency f2 will not dissociate, \*\* will also operate like one excitation child in the electric supply excitation child 11 and the non-supplied electric power excitation child 21, and the return loss will become shallow. If the joint capacity C12 becomes small, it will put in another way contrary to this and electrostatic capacity between the electric-field joint pattern 13 and 23 will be made small, the electric-field combination between the electric supply excitation child 11 and the non-supplied electric power excitation child 21 will become weak, and the frequency characteristic of strength and double resonance will no longer be obtained in operation which the electric supply excitation child 11 and the non-supplied electric power excitation child 21 became independent of, respectively.

[0033] Moreover, if loading capacity C1 and C2 is enlarged, the joint capacity C12 becomes small relatively, if it puts in another way, the electric-field combination in the electric-field joint patterns 13 and 23 will become weak, and the double resonance by resonance frequency f1 and f2 will not be obtained like \*\*\*\*. On the contrary, if loading capacity C1 and C2 is made small, the joint capacity C12 will become large relatively, and it will become that in which the capacity balance of an equal circuit collapsed. If it puts in another way, increase of the joint capacity C12 turns into increase of the electric-field combination in the electric-field joint patterns 13 and 23, and like \*\*\*\*, the resonance frequency f1 and f2 of the electric supply excitation child 11 and the non-supplied electric power excitation child 21 will approach, and it will not serve as double resonance.

[0034] Drawing 3 shows the concrete example of an operation form concerning the double resonant antenna of this invention. In drawing 3, the double resonant antenna 30 lays two antenna chips 41 and 51 in the circuit board 31 made considering resin material as a subject, and is constituted. The circuit wiring which antenna formation section 31a and grand section 31b are prepared in the front face, and does not illustrate the circuit board 31 in a rear face is formed. The

grand layer which stuck and formed copper foil etc. on the insulating substrate is prepared in grand section 31b. The electric-field joint patterns 32 and 33 of the couple of an abbreviation T typeface counter antenna formation section 31a of the circuit board 31 through the fixed interval g in a T character configuration portion, and pattern formation is carried out to it by the conductor.

[0035] Moreover, pattern formation of the grounding pattern 35 used as the electric supply pattern 34 and grounded circuit used as a feeder circuit is carried out to antenna formation section 31a. From the grand layer of grand section 31b, electric insulation of the electric supply pattern 34 is carried out, it is formed, and is connected to grand section 31b through the chip inductor 40. This electric supply pattern 34 is connected to the signal wiring which is not illustrated. Moreover, the grounding pattern 35 is connected to the grand layer of grand section 31b.

[0036] The electric-field joint patterns 32 and 33, the electric supply pattern 34, and the grounding pattern 35 which were mentioned above are the same conductor as the grand layer of grand section 31b, and pattern formation is carried out at once by the method of common knowledge, such as etching.

[0037] The antenna chips 41 and 51 equip the front face of the bases 43 and 53 of a dielectric with the radiation electrodes 42 and 52. The band-like electric-field joint terminals 44 and 54 are formed in the near edge (opposite edge) at which the radiation electrode 42 and the radiation electrode 52 counter. These electric-field joint terminals 44 and 54 hang the side of bases 43 and 53, respectively, and a nose of cam turns to the rear-face side of bases 43 and 53, and they are formed. And one electric-field joint terminal 44 is connected to the T character configuration portion of the electric-field joint pattern 32, and the edge of an opposite side, and the electric-field joint terminal 54 of another side is connected to the T character configuration portion of the electric-field joint pattern 33, and the edge of an opposite side.

[0038] Moreover, the band-like electric supply terminal 46 is formed, and this electric supply terminal 46 elongates the front face of a base 43 in the right-angled direction to the electric-field joint terminal 44, and the side of a base 43 is descended, and it turns to the rear-face side of a base 43, and is formed in the opposite edge of the radiation electrode 42. This electric supply terminal 46 is connected to the end of the electric supply pattern 34 prepared in the front face of the circuit board 31. The band-like earth terminal 56 is formed in the opposite edge of the radiation electrode 52, and this earth terminal 56 elongates the front face of a base 53 in the right-angled direction to the electric-field joint terminal 54, and it is prepared, and the side of a base 53 is descended, and it turns, is formed in the rear-face side of a base 53, and connects with the grounding pattern 35.

[0039] Furthermore, in the opposite side of the electric-field joint terminals 44 and 54, to the middle of the side of bases 43 and 53, the open end sections 47 and 57 of the radiation electrodes 42 and 52 hang, and are formed, respectively. And the fixed-end children 48 and 58 are formed in the same side which formed these open end sections 47 and 57 through the fixed interval to these open end sections 47 and 57. The fixed-end children 48 and 58 are elongated and formed to the rear face of bases 43 and 53, and are connected to the fixed patterns 36 and 37 formed in the circuit board 31.

[0040] In the above-mentioned concrete example of an operation form, it connects with the sending circuit and receiving circuit which are not illustrated, and the electric supply pattern 34 serves as a path of the RF current transmitted and received from the radiation electrodes 42 and 52. For example, sending-signal current is supplied to the electric-field joint terminal 54 through the electric-field joint patterns 32 and 33 from the electric-field joint terminal 44, and excites the resonance circuit of the radiation electrode 52 while it flows into the radiation electrode 42 from the electric supply terminal 46 and excites the resonance current. At this time, RF current flows towards a gland to an earth terminal 56.

[0041] The electric supply excitation child 41 and the non-supplied electric power excitation child 51 are doing electric-field combination by the electric-field joint patterns 32 and 33, by changing the amount of electric-field combination, can adjust combination between the electric supply excitation child 41 and the non-supplied electric power excitation child 51, and can get good double resonance matching. The equivalent capacity of the electric-field joint patterns 32 and 33 is decided by the electric-field joint pattern 32, the interval g between 33, and the length of an opposite portion.

[0042] Moreover, between the open end sections 47 and 57 of the radiation electrodes 42 and 52, and the fixed-end children 48 and 58, open end capacity is formed, respectively, and it works as a circuit element of the resonance circuit in the radiation electrodes 42 and 52, and becomes the element which determines the frequency of the resonance current which flows to the radiation electrodes 42 and 52.

[0043] Furthermore, the chip inductor 40 connected between the electric supply pattern 34 and grand section 31b adjusts the impedance of an antenna to the impedance of electric supply wiring, for example, 50 ohms, thereby, adjustment of the impedance between an antenna and the source 20 of a signal is acquired, and transmission and reception of a signal can make loss there be nothing. Moreover, it has combined with the grounding pattern 35

electrically through grand section 31b, and the chip inductor 40 serves as a path of the RF current which flows between the electric supply excitation child 41 and the non-supplied electric power excitation child 51. The chip inductor 40 became the impedance of the current circuit between the electric supply excitation child 41 and the non-supplied electric power excitation child 51, and has determined the amount of current combination between the electric supply excitation child 41 and the non-supplied electric power excitation child 51 here.

[0044] As mentioned above, by changing the composition between the electric-field joint pattern 32 and 33, the amount of electric-field combination between the electric supply excitation child 41 and the non-supplied electric power excitation child 51 can be determined, and the double resonance characteristic of an antenna can be adjusted. Moreover, by choosing the inductance value of the chip inductor 40, while adjusting the impedance of the antenna to an electric supply line, the amount of current combination between the electric supply excitation child 41 and the non-supplied electric power excitation child 51 can be adjusted.

[0045] In the above-mentioned example of an operation form, in addition, the radiation electrodes 42 and 52 of the electric supply excitation child 41 and the non-supplied electric power excitation child 51 Since it formed in the shape of field symmetry type, in case the radiation electrodes 42 and 52 are formed by screen-stencil etc., for example to the non-supplied electric power excitation child's 51 radiation electrode 52 Since the reverse pattern of the mask used by the electric supply excitation child's 41 radiation electrode 42 can be used, the manufacturing cost of the chip antennas 41 and 51 can be reduced.

[0046] Moreover, although only the electric-field joint patterns 32 and 33, the electric supply pattern 34, the grounding pattern 35, and the fixed patterns 36 and 37 are formed in antenna formation section 31a of the circuit board 31 and a grand layer does not exist in it in the above-mentioned example of an operation form, the fixed patterns 36 and 37 may be lengthened and you may connect with the grand layer of grand section 31b. These are decided in consideration of the antenna double resonance characteristic.

[0047] Furthermore, in the above-mentioned example of an operation form, although the chip antennas 41 and 51 have arranged the longitudinal direction in the shape of a straight line, the array can define them freely at the time of a design. For example, it may arrange in the shape of a right angle, and the longitudinal direction of the chip antennas 41 and 51 may lean [ as opposed to / another side / in arrange \*\*\*\* ] the chip antennas 41 and 51 mutually, for example, may arrange one side into the character of HA so that a longitudinal direction may become parallel / the chip antennas 41 and 51 /.

[0048] Since the arrangement of the chip antennas 41 and 51 of free arrangement of such chip antennas 41 and 51 which formed the electric-field joint patterns 32 and 33 in the circuit board 31, becomes realizable for the first time by composition which carries out electric-field combination, and set two chip antennas 41 and 51 by the case of a walkie-talkie machine by this using these electric-field joint patterns 32 and 33 is attained, the flexibility of a double resonant-antenna design increases.

[0049] Furthermore, in the above-mentioned example of an operation form, in the double resonance state, since it has the original resonance frequency  $f_1$  and  $f_2$ , as for the chip antennas 41 and 51, the size may be mutually different, and the specific inductive capacity of bases 43 and 53 can also make the chip antennas 41 and 51 different mutually, and the formation front face of the radiation electrodes 42 and 52 also of the configuration of bases 43 and 53 may be not only a rectangle but a square again.

[0050] Furthermore, in the above-mentioned example of an operation form, although two chip antennas 41 and 51 made the configuration of the radiation electrodes 42 and 52 symmetrical with a field, as for this, they may be unsymmetrical, for example, may form one radiation electrode in a tabular, and may form the radiation electrode of another side in a MIANDA configuration again. Moreover, when forming the radiation electrodes 42 and 52 of two chip antennas 41 and 51 in a MIANDA configuration, it can design freely one side being able to elongate the radiation electrode of the letter of a \*\* face crease to the longitudinal direction on the front face of a base, and being able to consider another side as the composition elongated in the direction of a short hand on the front face of a base, and using one side as the radiation electrode of the letter of a \*\* face crease, and using another side as a swirl-like radiation. Therefore, the flexibility of a design becomes large in case the radiation electrodes 42 and 52 of two chip antennas 41 and 51 are formed.

[0051] the above -- by any case of the example of an operation form, since the large field as a double resonant antenna can be taken even if an electric supply excitation child and a non-supplied electric power excitation child constitute small by using the circuit board, the electric volume of an antenna increases and the double resonant antenna of a large high interest profit of frequency bandwidth can be manufactured cheaply

[0052] The example of an operation form shown in drawing 4 or drawing 6 shows other composition which combines electrically an electric supply excitation child and a non-supplied electric power excitation child, and gives the same sign to the same component as the example of an operation form of drawing 3 , and duplication explanation of the

intersection is omitted.

[0053] In drawing 4, the electric-field joint pattern 61 which connects the electric supply excitation child 41 is formed in the front face of antenna formation section 31a in the circuit board 31, and the electric-field joint pattern 62 which connects the non-supplied electric power excitation child 51 is formed in the rear face of the circuit board 31. The amount of [ of the electric-field joint patterns 61 and 62 ] point has lapped up and down through the circuit board 31, between the electric-field joint pattern 61 and 62, the joint capacity according to the thickness and the opposed face product of the circuit board 31 occurs, and it carries out capacity coupling of between the electric supply excitation child 41 and the non-supplied electric power excitation child 51.

[0054] This joint capacity can be changed by changing the opposed face product of the electric-field joint patterns 61 and 62. Moreover, the non-supplied electric power excitation child's 51 electric-field joint terminal 54 is connected to the relay pattern 63 prepared in the front-face side of the circuit board 31, and this relay pattern 63 is connected to the electric-field joint pattern 62 through a through hole 64.

[0055] The example of an operation form shown in drawing 5 is different from the example of an operation form of drawing 4 at the point which has stationed the non-supplied electric power excitation child 51 to the rear-face side of the circuit board 31. The non-supplied electric power excitation child's 51 electric-field joint terminal is connected to the direct electric-field joint pattern 62 like drawing 3. The fixed pattern 66 is formed in the rear face of the circuit board 31, and the non-supplied electric power excitation child's 51 fixed-end child 58 is connected to this fixed pattern 66. By this composition, the space on the rear face of front of antenna formation section 31a in the circuit board 31 is used effectively.

[0056] Moreover, two electric-field joint patterns 68 and 69 are combined by the capacitor 70 instead of the example of an operation form of drawing 6 arranging two electric-field joint patterns 68 and 69 as electric-field coupling means 29 through the interval in which joint capacity is formed. A chip capacitor is used for a capacitor 70. Between the electric supply excitation child 41 and the non-supplied electric power excitation child 51, it is combined by the capacitor 70 by this composition, and the degree of coupling between the electric supply excitation child 41 and the non-supplied electric power excitation child 51 is changeable by changing the capacity value of a capacitor 70 with composition.

[0057] The example of an operation form shown in drawing 7 or drawing 11 shows other composition which adjusts the amount of current combination between an electric supply excitation child and a non-supplied electric power excitation child while adjusting the impedance of a double resonant antenna to the source of a signal, and it gives the same sign to the same component as the example of an operation form of drawing 3, and duplication explanation of the intersection is omitted.

[0058] In drawing 7 and drawing 8, it replaces with the inductance circuit which used the chip inductor 40 of drawing 3, and the electrode pattern 71 which connected the end to the electric supply terminal 46 is formed in the side of the electric supply excitation child's 41 base 43. The other end of this electrode pattern 71 is connected to the grand layer of grand section 31b through the connection pattern 72 formed in antenna formation section 31a of the circuit board 31. The electrode pattern 71 is formed in a MIANDA configuration, and an inductance component is given.

[0059] In this composition, the impedance of a double resonant antenna is adjusted by the inductance value of the electrode pattern 71 to the source of a signal like the chip inductor 40 of drawing 3. Moreover, the connection pattern 72 is electrically combined with the grounding pattern 35 through grand section 31b, current combination is carried out through the impedance of the electrode pattern 71 between the electric supply excitation child 41 and the non-supplied electric power excitation child 51, and the amount of current which flows between the electric supply excitation child 41 and the non-supplied electric power excitation child 51 is adjusted. In this case, when the connection pattern 72 and the grounding pattern 35 approach and are prepared, the amount of current which flows the grounding pattern 35 also by magnetic field combination can be decided.

[0060] According to above-mentioned composition, since it is formed in the front face of the base 43 in the electric supply excitation child 41, when producing the electric supply excitation child 41, the electrode pattern 71 can be formed by the same manufacture method as formation of the radiation electrode 42, and can form the connection pattern 72 in the circuit board 31 simultaneously with formation of the electric supply pattern 34 and the grounding pattern 35.

[0061] The example of an operation form of drawing 9 is different from the example of an operation form of drawing 7 at the point prepared in the circuit board 31 instead of preparing the pattern which has an inductance component in the base 43 of the antenna chip 41. In addition, in order to show the composition of invention clearly, the dotted line shows the chip antennas 41 and 51. The inductance pattern 73 of a MIANDA configuration connected with the electric supply pattern 34 as an inductance circuit is formed in the front face of antenna formation section 31a of the circuit board 31.

[0062] The inductance value of the inductance pattern 73 is set as the value from which the transceiver signal power from a double resonant antenna serves as the maximum. Moreover, the inductance pattern 73 is connected to the grand

layer of grand section 31b near the grounding pattern 35, and the inductance pattern 73 and the grounding pattern 35 carry out magnetic field combination with current combination.

[0063] That is, since the amount of current which flows the inductance pattern 73 and the grounding pattern 35 is large, the magnetic field strength generated from these patterns 35 and 73 becomes large. Also in this case, like \*\*\*\*\*, the inductance pattern 73 determines two chip antennas 41 and the amount of current combination between 51 while adjusting an impedance, and also it adjusts two chip antennas 41 and the amount of current which flows between 51 with the amount of magnetic field combination.

[0064] The example of the drawing 10 operation form gives the means of magnetic field combination between the chip antenna 41 and 51 to the example of an operation form shown in drawing 3. In addition, the dotted line shows the chip antennas 41 and 51. Bend 74a is prepared in the grounding pattern 74 which connects the earth terminal 56 of the chip antenna 51, the electric supply pattern 34 is approached, and it connects with the grand layer of grand section 31b.

[0065] According to this composition, in addition to the adaption function by the chip inductor 40 mentioned above, to the electric supply pattern 34 and the grounding pattern 74, magnetic field combination arises from there being many amounts of current which flow to the electric supply pattern 34, and the chip antenna 41 and the amount of current which flows between 51 can be adjusted. Moreover, the joint degree between the grounding pattern 74 and the electric supply pattern 34 is changeable by changing the form of bend 74a.

[0066] Moreover, drawing 11 is two chip antennas 41 and the example of an operation form which prepared the inductor among 51 and carried out direct current combination. In addition, the dotted line shows the chip antennas 41 and 51. The electric supply drawer patterns 75 are formed successively, from the grounding pattern 35, the grounding drawer pattern 76 is pulled out to the electric supply pattern 34 formed in the circuit board 31, and the inductor 77 is connected to it between this electric supply drawer pattern 75 and the grounding drawer pattern 76. Moreover, the chip antenna 41 and the electric-field joint patterns 78 and 79 which carry out electric-field combination of between 51 have constituted and countered the abbreviation L typeface.

[0067] With this composition, by selecting the inductance value of an inductor 77, the impedance matching of the double resonant antenna to the source of a signal, two chip antennas 41, and the amount of current that flows between 51 can be adjusted directly, and the design of a double resonant antenna becomes easy about it by the inductor 77. Moreover, although the electric-field combination by the electric-field joint patterns 78 and 79 becomes weak compared with the electric-field joint patterns 32 and 33 of the abbreviation T typeface of the example of an operation form shown in drawing 3, the configuration of the electric-field joint patterns 78 and 79 is decided in consideration of adjustment with the direct current combination by the inductor 77.

[0068] By adoption of above-mentioned composition, the electric supply pattern 34 and the grounding pattern 35 carry out current combination directly through an inductor 77. With the inductance value, an inductor 77 determines the amount of current which flows between the electric supply pattern 34 and the grounding patterns 35 while adjusting the impedance between a double resonant antenna and the source of a signal.

[0069] The example of the drawing 12 operation form shows the composition of 2 \*\*\*\*\* resonant antenna which put side by side two double resonant antennas of the example of an operation form shown in drawing 3 on the one circuit board. The chip antennas 81 and 82 are a pair of chip antennas which produce double resonance, and are chip antennas used as the pair from which the chip antennas 91 and 92 also produce double resonance. Electric-field combination of the chip antennas 81 and 82 is carried out through the electric-field joint patterns 83 and 84, and electric-field combination also of the chip antennas 91 and 92 is carried out through the electric-field joint patterns 93 and 94.

[0070] The chip antennas 81 and 91 are connected to the common electric supply pattern 85, and signal power is simultaneously switched on from the source of a signal. The inductor 86 is connected with the common electric supply pattern 85 between the grand layers of grand section 31b, and the impedance of two double resonant antennas is adjusted to the source of a signal. Moreover, two chip antennas 82 and 92 are connected to the grand layer of grand section 31b through the grounding patterns 87 and 88, respectively.

[0071] In this composition, the frequency band of the double resonance by the chip antennas 81 and 82 and the double resonance by the chip antennas 91 and 92 detaches, and is set up. For example, when the chip antennas 81 and 82 double-resonate by the frequency band which is 800-900MHz, the chip antennas 91 and 92 are set up so that it may double-resonate with a 1700-2100MHz band. If it puts in another way, two or more double resonant antennas which can be set to the frequency band left to the grade which does not produce interference mutually can be designed using the common circuit board.

[0072]

[Effect of the Invention] Since the electric-field coupling means which combine between both excitation children apart from an electric supply excitation child and a non-supplied electric power excitation child were prepared according to the double resonant antenna of a claim 1, the double resonant antenna which was excellent in the frequency

characteristic in a reflection loss can be obtained by optimizing the electric-field combination between both excitation children. And by setting up the composition of electric-field coupling means suitably, it can respond to expansion of the size of the whole antenna flexibly, and the electric volume of an antenna can be increased, without changing the composition of an electric supply excitation child and a non-supplied electric power excitation child.

[0073] Moreover, since electric-field coupling means are formed independently of an electric supply excitation child and a non-supplied electric power excitation child, they can offer the antenna with which the flexibility of a design of an antenna can bear enough the use of increase and large power transmission and reception. Furthermore, since the space containing an electric supply excitation child, a non-supplied electric power excitation child, and electric-field coupling means can be used as electric volume of the whole antenna, the antenna of a wide band and high interest profit is realizable.

[0074] According to the double resonant antenna of a claim 2, since the electric-field joint pattern of a couple was prepared independently of the electric supply excitation child and the non-supplied electric power excitation child, the amount of electric-field combination between an electric supply excitation child and a non-supplied electric power excitation child can be adjusted by adjusting the capacity between electric-field joint patterns.

[0075] Although the electromagnetic coupling between both excitation children is adjusted in the former by changing the composition of an electric supply excitation child and a non-supplied electric power excitation child. Since capacity coupling between the electric-field joint patterns of the couple formed in the circuit board adjusts the amount of electric-field combination between an electric supply excitation child and a non-supplied electric power excitation child in this invention while being able to choose freely the arrangement form of an electric supply excitation child and a non-supplied electric power excitation child, you may differ, even if the configuration, size, and dielectric constant of the base which constitutes an excitation child are also the same as mutual, and the configuration and orientation of a radiation electrode do not receive a limit at all, either.

[0076] Therefore, since it is possible to perform frequency of a double resonant antenna and adjustment of a delta frequency by the electric-field joint pattern, the design of the increase of the flexibility of a double resonant-antenna design and a double resonant antenna becomes easy. Since the electric-field joint pattern formed on the circuit board performs the degree of electric-field combination especially, the double resonant antenna of the use which transmits and receives an electric wave with large power is producible.

[0077] Moreover, the base of a dielectric is used only for the portions of an electric supply excitation child and a non-supplied electric power excitation child, and since the electric-field joint pattern which carries out electric-field combination of an electric supply excitation child and the non-supplied electric power excitation child was constituted on the circuit board, unlike the antenna with which the whole double resonant antenna consists of bases of a dielectric, it can carry out the design by which the size of a double resonant antenna was changed flexibly like before.

[0078] Since the base of ceramic material is used only for the portions of an electric supply excitation child and a non-supplied electric power excitation child and it is not necessary to use the base of the ceramic material of the big size as a dielectric for the whole double resonant antenna when the dielectric of a double resonant antenna is especially constituted from ceramic material, an electric supply excitation child and a non-supplied electric power excitation child can be produced with a sufficient process tolerance, and a double resonant antenna can be made cheaply and lightweight.

[0079] Furthermore, since flexibility is in each arrangement of an electric supply excitation child and a non-supplied electric power excitation child, according to the case of the mobile communication equipment with which a double resonant antenna is incorporated, arrangement of an electric supply excitation child and a non-supplied electric power excitation child can be determined flexibly. Even in such a case, since the whole field containing the electric supply excitation child, the non-supplied electric power excitation child, and the electric-field joint pattern is used as electric volume of a double resonant antenna, the double resonant antenna of a large high interest profit of frequency bandwidth is realizable.

[0080] Since an electric-field joint pattern is prepared in the circuit board independently of an electric-supply excitation child and a non-supplied electric power excitation child according to the double resonant antenna of a claim 3, it can consider as various pattern composition, without taking into consideration the composition of an electric-supply excitation child and a non-supplied electric power excitation child, and adjustment of the delta frequency between setup and the electric supply excitation children, and the non-supplied electric power excitation children of the resonance frequency of an electric supply excitation child and a non-supplied electric power excitation child in double resonance becomes that it is easy

[0081] According to the double resonant antenna of a claim 4, since between electric-field joint patterns is combined by the capacitor, it can consider as the optimal double resonant antenna by choosing the value of a capacitor.

[0082] According to the double resonant antenna of a claim 5, since adjustment combination current coupling means

were prepared between the electric supply excitation child and the non-supplied electric power excitation child, it is easy in impedance matching with the source of a signal, and a flexible design becomes possible when increasing the electric volume of an antenna, without between an electric supply excitation child's and a non-supplied electric power's excitation child magnetic field being combinable and combinable, and taking into consideration the arrangement relation between an electric supply excitation child and a non-supplied electric power excitation child.

[0083] Moreover, since adjustment combination current coupling means can be designed separately from an electric supply excitation child and a non-supplied electric power excitation child, they can set up the size of a double resonant antenna freely, without deforming the configuration of an electric supply excitation child and a non-supplied electric power excitation child, and can obtain the double resonant antenna suitable for the use of large power transmission.

[0084] Furthermore, with the impedance of this inductance circuit, when adjustment combination current coupling means are constituted from an inductance circuit, while being able to adjust the impedance of the double resonant antenna to a feeder circuit, even if the amount of current which flows between an inductance circuit and a grounded circuit is large, the amount of current can be adjusted certainly. Moreover, the amount of current which flows to a grounded circuit also by magnetic field combination can be adjusted by approaching and arranging circuit wiring of an inductance circuit in a grounded circuit.

[0085] Furthermore, when adjustment combination current coupling means include the composition in which a part of grounded circuit was made to approach a feeder circuit again, while being able to adjust the amount of current which flows to a grounded circuit by magnetic field combination, the joint degree between a grounded circuit and a feeder circuit is changeable by adjusting adjustment combination current coupling means.

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[Translation done.]

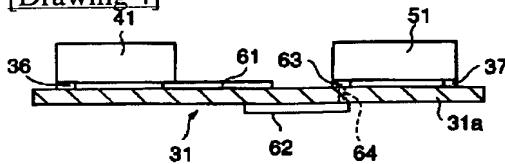
## \* NOTICES \*

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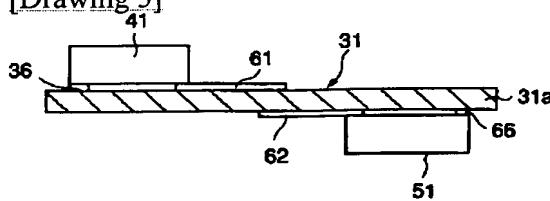
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

## DRAWINGS

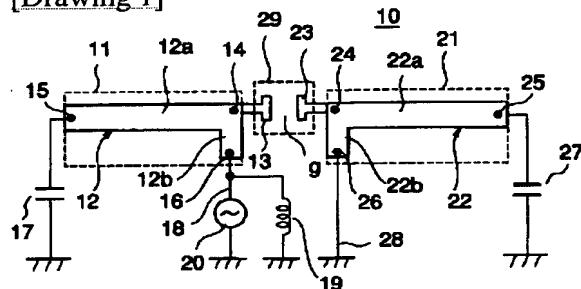
## [Drawing 4]



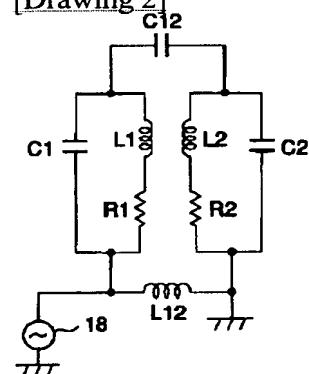
## [Drawing 5]



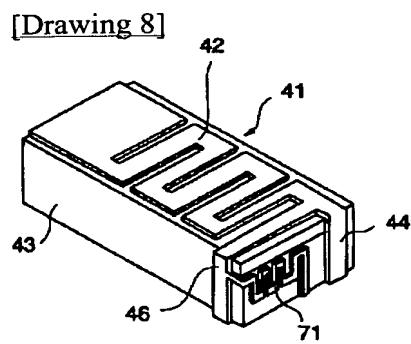
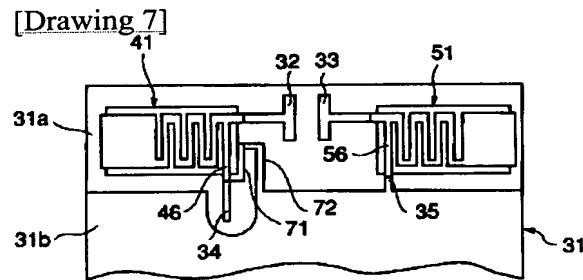
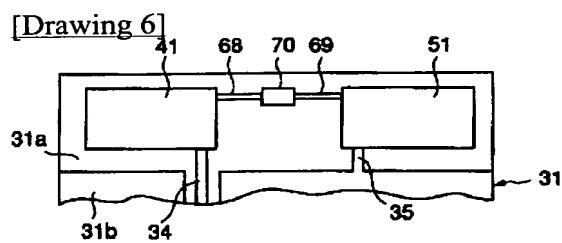
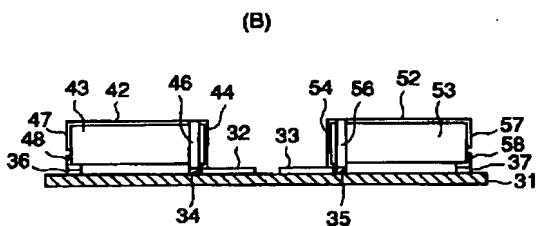
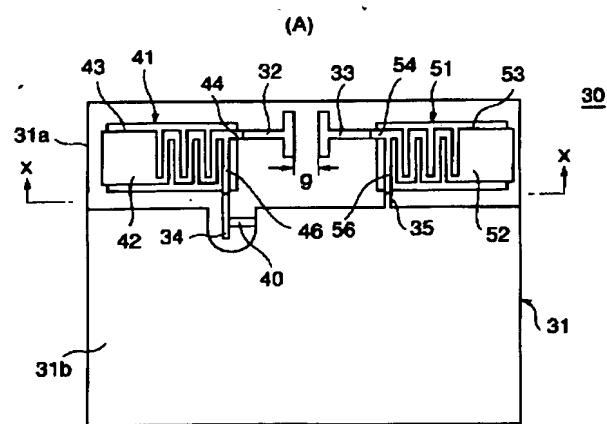
## [Drawing 1]



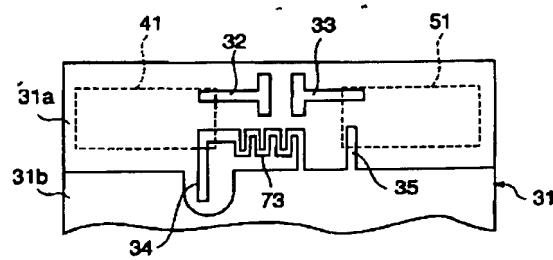
## [Drawing 2]



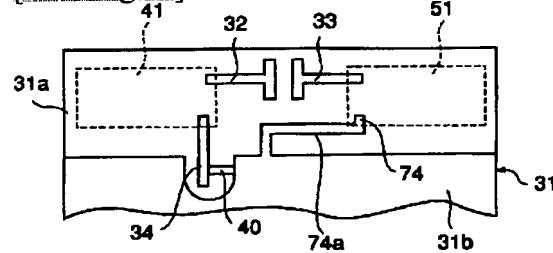
## [Drawing 3]



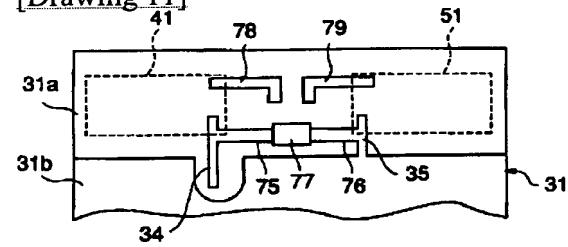
**[Drawing 9]**



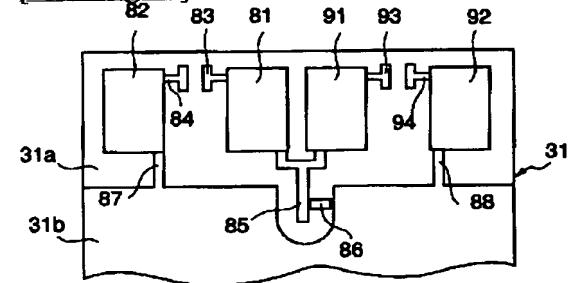
[Drawing 10]



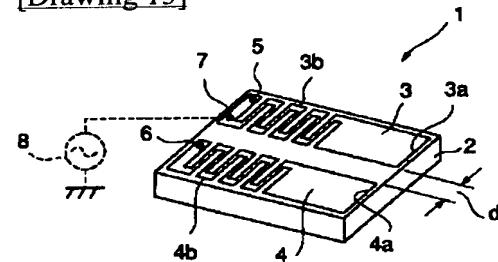
[Drawing 11]



[Drawing 12]



[Drawing 13]




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[Translation done.]